REMARKS

This paper is responsive to the non-final Office Action mailed June 8, 2009. Claims 1, 4, 7-22, 24, 26, 27, and 29 are pending in the application and stand rejected. Claims 1, 14, 17, 24, and 29 have been amended. Claim 30 has been added and depends from Claim 1. Reconsideration and allowance of Claims 1, 4, 7-22, 24, 26, 27, 29, and 30 are respectfully requested in view of the above amendments and following remarks.

The Examiner Interview of October 7, 2009 and Related Communications

A telephonic conference between the undersigned attorney and the Examiner was held on October 7, 2009. The rejections of the pending claims were discussed, particularly with regard to Claim 1. In the outstanding Office Action, the Examiner has indicated that the claims recite polyimides in a product-by-process fashion, which renders the scope of the claims to broadly recite all polyimides instead of the intended limitation of the claims to the recited genera and species (e.g., in Claim 1, the reaction product incorporating one of genus (1)-(3)).

The Examiner graciously agreed to review a proposed amendment that would seek to remedy the broad interpretation of the claims by the Examiner.

A proposed amendment to Claim 1, and related remarks, were transmitted to the Examiner on October 30, 2009. The Examiner responded to the proposed amendment in a voice mail to the undersigned attorney on November 6, 2009. Upon reviewing the proposed amendment, the Examiner stated that if the proposed amendment were officially submitted, the amended claims would be considered.

No conclusion was reached with regard to the claims in either the Examiner interview of October 7, 2009 or the voice mail from the Examiner on November 6, 2009.

The undersigned attorney thanks the Examiner for a productive correspondence regarding this application.

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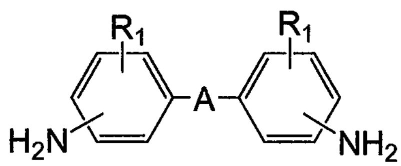
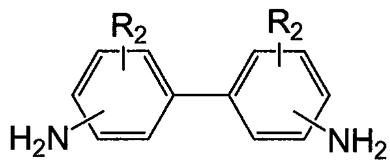
The Claimed Invention

Claim 1, from which Claims 4, 7-9, and 11-13 depend, recites an electrolyte membrane that includes a porous substrate filled with a first polymer having proton connectivity. As amended, Claim 1 recites that the porous substrate consists of the polyimide reaction product of a biphenyl tetracarboxylic acid dianhydride and a diamine selected from the group consisting of



(1)



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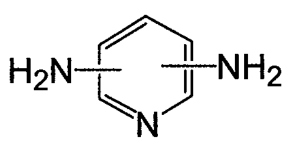

(3)

Wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, a lower alkyl group, and a lower alkoxy group. Wherein A is a divalent moiety selected from the group consisting of O, S, CO, SO_2, SO, CH_2 and $C(CH_3)_2$. Various characteristics of the porous substrate are also recited. Claims 4, 7-13, 29 and 30 depend from Claim 1. New Claim 30 further defines R_1 and R_2 and A groups in Claim 1.

Claim 14 recites a method for producing an electrolyte membrane similar to that of Claim 1. However, instead of reciting chemical genera, as in Claim 1, Claim 14 recites that the porous polyimide substrate consists of the polyimide reaction product of 3,3',4,4'-biphenyltetracarboxylic acid dianhydride and oxydianiline (i.e., a single reaction product

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species). Claims 15, 16, and 18-22 depend from Claim 14. Claim 29, which depends from Claim 1, has been amended similarly to Claim 14.

Claim 17 has been amended similarly to Claim 14.

Claim 24, from which Claims 26 and 27 depend, has been amended similarly to Claim 14.

Support for the amendments can be found throughout the application as filed.

<u>Product-by-Process Claims</u>

The Examiner has indicated in the outstanding Office Action, as well as during the Examiner correspondence described above, that the pending independent claims recite product-by-process style limitations, which do not sufficiently limit the claimed subject matter to the chemical species recited in the claims.

For example, Claim 1 recites an electrolyte membrane comprising, *inter alia*, a porous substrate consisting of one of three genera of polyimides formed by reacting a biphenyl tetracarboxylic acid dianhydride with one of three genera of diamines (1)-(3). Claim 1 stands rejected, as will be described in further detail below, in view of the Takeo reference (EP1202365), which teaches only "a polyimide" substrate. While the compounds formed by Claim 1 *are* polyimides, they are very specific genera that are not taught by, or otherwise obvious in view of, the Takeo reference.

The Examiner has indicated that Claim 1 does not sufficiently limit the recited polyimides to the genus of the reaction products of (1)-(3) because the claim is in a product-by-process style. Thus, the Examiner has interpreted the claim as reciting <u>all polyimides</u>, instead of the intended limitation of the claim to the recited products of (1)-(3).

During the conference of October 7, 2009, the Examiner indicated that defining the recited genera more clearly may address the above-discussed issues with regard to the present

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broad interpretation of Claim 1. Claim 1, as amended, positively defines the specific genera of polyimides formed.

Additionally, for the Examiner's reference, attached hereto is Exhibit A, an excerpt from *Polymer Chemistry* (Malcolm Stevens, Oxford University Press, 1999) that discuss polyimides formed from dianhydrides and diamines (Schemes 13.53 and 13.54). These schemes demonstrate that one of skill in the art would know the specific genera recited by the claimed reaction products. For example, the recited biphenyltetracarboxylic acid would replace compound **33** in Scheme 13.53 and one of genera (1)-(3) would replace the $H_2N\text{-}R\text{-}NH_2$ diamine of Scheme 13.53. Thus, the reaction product of such a reaction is defined by the composition of the dianhydride and the diamine "R group" as illustrated in Scheme 13.54.

Independent Claims 14, 17, and 24, and Claim 29, which depends from Claim 1, all recite specific species of reaction products, which would be understood by one of skill in the art to form a specific reaction product thus these claims, and those depending therefrom, recite a specific species of polyimide as the porous substrate.

Applicants believe that the amended claims properly limit the invention to the recited genera and species of each claim.

<u>Antecedent Basis</u>

The Examiner indicated in the voice mail of November 6, 2009, that the proposed amended Claim 1 (which is now amended Claim 1, above) was defective for lack of antecedent basis related to the term "polyimide reaction product." The claim originally recited "a polyimide, which is obtained from..." whereas amended Claim 1 recites "the polyimide reaction product..." The use of "the" in the amended claim eliminates the recitation of a general polyimide, and clarifies that the claim does not recite <u>all polyimides</u>, but only the polyimide reaction product of the recited reaction.

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Applicants believe that the amended language of Claim 1 does not lack antecedent basis, as defined in M.P.E.P. 2173.05(e), which only requires that a claim be free of "words or phrases whose meaning is unclear." The amended claims do not further recite a reference back to the "polyimide reaction product" and thus, there is no need to provide antecedent basis for the term using the article "a". The amended claim has a clear meaning.

Intended Use Language

In the outstanding Office Action, the Examiner has noted that Claims 1, 14, 17, and 24 have intended use language when reciting the thermal shrinkage ratio of the formed materials "upon thermal treatment." During the Examiner interview of October 7, 2009, the Examiner suggested that amending the claim to recite "after thermal treatment" would remedy this issue. Applicants have amendment the claims accordingly.

The Rejection of Claims 1, 4, 7-13, 24, 26, 27, and 29 Under 35 U.S.C. §§ 102(b) or 103(a)

Claims 1, 4, 7-13, 24, 26, 27, and 29 stand rejected under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Takeo et al. (EP1202365). Withdrawal of this ground for rejection is respectfully requested for the following reasons.

The independent claims at issue in this rejection, Claims 1 and 24, all recite specific species (or genera) of polyimide compounds useful for making electrolytic membranes for fuel cells. The Examiner relies on Takeo et al. as teaching a product and process for making a fuel cell comprising a porous polyimide electrolyte. It is asserted that Takeo et al. teaches a broad genus that includes polyimide materials useful for making porous fuel cell materials. However, for the following reasons, the disclosure of such a broad genus is not anticipatory nor does it make obvious the specific species and narrow genera recited in Claims 1 and 24 and those claims depending therefrom.

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A discussion of the anticipation of a species by a genus taught by a prior art reference can be found in M.P.E.P. § 2131.02, which states that "if one of ordinary skill in the art is able to 'at once envisage' the specific compound within the generic chemical formula, the compound is anticipated." (M.P.E.P. § 2131.02 citing *Ex Parte A*, 17 U.S.P.Q. 2d 1716 (Board of Patent Appeals and Interferences 1990). Further, "one of ordinary skill in the art must be able to draw the structural formula or write the name of each of the compounds included in the generic formula before any of the compounds can be 'at once envisaged.'" (*Ibid.*) The Takeo et al. reference only mentions polyimide once in the reference (at ¶ [0017]) and does not teach any specific embodiments that include polyimides. Thus, Takeo et al. teaches an almost infinite number of polyimides but teaches no specific examples of such polyimides. Because the invention as set forth in Claims 1 and 24 recite specific species of polyimides that are not taught or suggested by Takeo et al. (and thus cannot be at once envisaged by a reader of the reference), it is submitted that the reference is not anticipatory.

Furthermore, because Takeo et al. does not teach, suggest, or otherwise make obvious the specific species of polyimides set forth in Claims 1 and 24, it is submitted that the claimed invention is not obvious in view of Takeo et al.

For these reasons, withdrawal of this ground for rejection is respectfully requested.

<u>The Rejection of Claims 14-22 Under 35 U.S.C. § 103(a)</u>

Claims 14-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Takeo et al. in view of Brunner (U.S. Patent No. 3542703). Withdrawal of this ground for rejection is respectfully requested for the following reasons.

Claims 14-22 include the recitation (in Claims 14 and 17) that the porous substrate is the reaction product of 3,3',4,4'-biphenyltetracarboxylic acid dianhydride and oxydianiline. Thus, a single species of polyimide porous substrate is recited.

The Examiner characterizes Takeo et al. (as described above) as teaching a polyimide porous substrate and relies on Brunner et al. as teaching a polyimide formed from 3,3',4,4'-biphenyltetracarboxylic acid and oxydianiline. The Examiner believes that one of skill in the art would combine the teachings of Brunner et al. and Takeo et al. to arrive at the claimed invention. Applicants assert that the combined teachings of Takeo and Brunner do not teach, suggest, or otherwise make obvious the specific species of porous substrate recited in Claims 14-22.

Brunner et al. teaches a composition that comprises (1) a bis ester of an aromatic tetracarboxylic acid, (2) an inert organic solvent, (3) melamine, and (4) an aromatic diamine (Abstract). Brunner et al. explicitly teaches that the addition of melamine results in compositions with improved thermal stability (Col. 2, lines 59-64). Brunner et al. also teaches that the composition is useful as a varnish, syrup, coating, or impregnating/adhesive agent (Col. 2, lines 64-66). It is submitted that Brunner et al. does not teach the polyimide of the claimed invention because, *inter alia*, the reference teaches a polymer that includes melamine as an essential element, whereas the polyimide of Claims 14-22 is obtained from 3,3',4,4'-biphenyltetracarboxylic acid and oxydianiline with no melamine. Relatedly, Brunner et al. does not teach or suggest the pores, pore sizes, heat resistance, and thermal shrinkage recited in Claims 14-22.

Additionally, one of ordinary skill in the art would not be motivated to combine the polyimide taught by Brunner et al. to form a porous substrate for supporting an electrolyte as taught by Takeo et al. because the porous substrate taught by Takeo et al. is a self-supporting substrate that is then filled with an electrolyte to occupy the pores of the substrate. Brunner et al. does not teach or suggest the use of the taught polyimide composition as a porous substrate having the characteristics recited in Claim 1 (e.g., pore diameter of 0.01 to 1 microns and heat resistant temperature of 200°C). Brunner et al. teaches the use of the disclosed polyimides as a

varnish, syrup, coating, or impregnating/adhesive agent, but not as a substrate. Thus, one of ordinary skill in the art would not be motivated to use the polyimide coating of Brunner et al. as a porous substrate as taught by Takeo et al. to arrive at the claimed invention.

For the above-stated reasons, applicants assert that Claims 14-22 are not obvious in view of the combined teachings of Takeo et al. and Brunner et al. and withdrawal of this ground for rejection is respectfully requested.

CONCLUSION

Applicants believe that the application is now in condition for allowance. Reconsideration and favorable action are requested. If any issues remain that may be expeditiously addressed in a telephone interview, the Examiner is encouraged to telephone the undersigned attorney at 206-695-1698.

Respectfully submitted,

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EXHIBIT A

THIRD EDITION

POLYMER CHEMISTRY

AN INTRODUCTION

Malcolm P. Stevens
University of Hartford

New York   Oxford

Oxford University Press

Oxford New York
Athens Auckland Bangkok Bogotá Buenos Aires Calcutta
Cape Town Chennai Dar es Salaam Delhi Florence Hong Kong Istanbul
Karachi Kuala Lumpur Madrid Melbourne Mexico City Mumbai
Nairobi Paris São Paulo Singapore Taipei Tokyo Toronto Warsaw

and associated companies in
Berlin Ibadan

Published by Oxford University Press, Inc.
198 Madison Avenue, New York, New York 10016
http://www.oup-usa.org

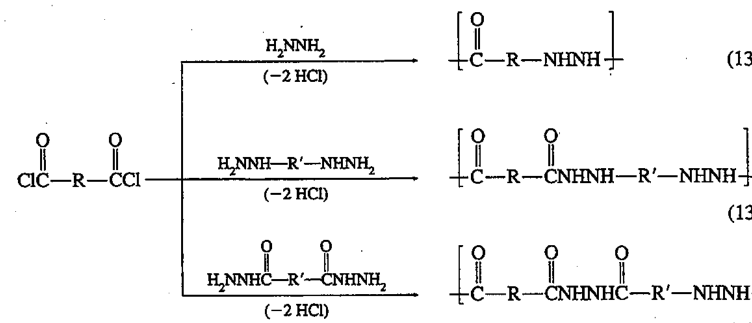
Library of Congress Cataloging-in-Publication Data
Stevens, Malcolm P., 1934–
Polymer chemistry : an introduction / Malcolm P. Stevens. — 3rd ed.
p. cm.
Includes bibliographical references and index.
ISBN 0-19-512444-8 (hardcover)
1. Polymers. 2. Polymerization. I. Title.
QD381.S73 1999 98-23083
547'.7—dc21 CIP

Printing (last digit): 9 8 7 6 5 4
Printed in the United States of America

To Marcia,
Jeff, Mandy, Megan and Matthew
Phil and Laurissa

13.6 Polyhydrazides

There are three general methods of preparing polyhydrazides[8]; the reaction of a diacid chloride with hydrazine or hydrazine hydrate (13.49), with a dihydrazine (13.50), and with a dihydrazide (13.51). Of the three, the dihydrazide route (13.51) is preferred because the monomers are easily prepared from diesters and hydrazine and are easily purified. Hydrazine is readily available, but it is so hygroscopic that it is difficult to achieve an exact stoichiometric balance. Furthermore, one amino group of hydrazine is sufficiently less reactive than the other that condensations of this type (13.49) must be run in solution and cannot be done by interfacial polymerization.

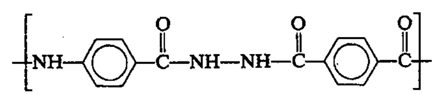


(13.49)

(13.50)

(13.51)

These polymers have not achieved commercial importance, although there has been interest in aromatic polyhydrazides as high-modulus, thermally stable fibers[32] and because they may exhibit liquid crystalline properties.[56] Tire cord represents a potential market for materials of this type. Polyamidehydrazides such as **32** are also of interest.[35] In Chapter 15 we shall see how polyhydrazides may be converted to heterocyclic polymers.



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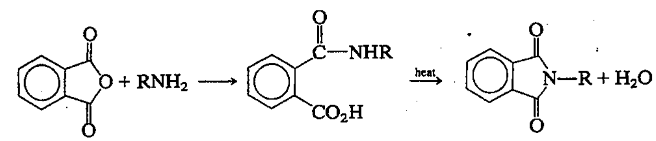
13.7 Polyimides

Although imides may have an open-chain structure, it is the cyclic imides that are of interest in polymer chemistry. Such imides are most commonly prepared from cyclic anhydrides and ammonia or amines via the intermediate amide-acid (13.52).

Polyimides have experienced extremely rapid development in recent years,[57–62] the major emphasis being on engineering applications. High-strength composites, thermally stable films, molding compounds, and adhesives are numbered among the products.

Oxidative and hydrolytic stability, in addition to thermal stability, are characteristic of polyimides.

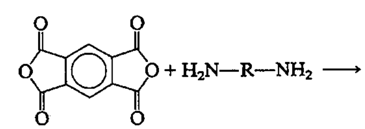


(13.52)

There are two types of polyimides:

1. *Condensation polyimides*, in which the imide functional group or its precursor is formed during the polymerization reaction.
2. *Addition polyimides*, which consist of low-molecular-weight, usually oligomeric imide-containing, compounds or mixtures of compounds having reactive terminal groups that upon heating undergo addition polymerization to yield network polymers.

Condensation polyimides were the first to be developed.[62–64] The reaction, illustrated with pyromellitic dianhydride (**33**), involves initial formation of polyamide (13.53) followed by ring closure to form polyimide (13.54). The formation of a stable five-membered ring is the driving force for forming linear rather than crosslinked polymer.



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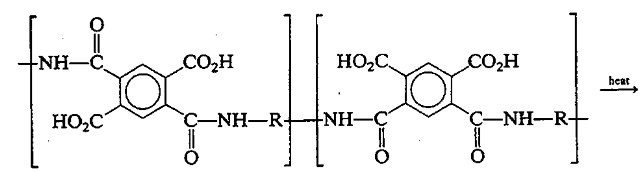

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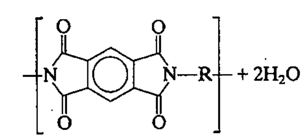

(13.54)

If R is aliphatic in the above equations, the two steps may be run in one operation. If R is aromatic, however, the final product is infusible and insoluble, and the second step must